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TWO ADDITIONAL CHARGED BEAMS IN THE MESON AREA

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We propose two new charged beams in the Meson Area. The present M4 neutral kaon beam can be interchangeably converted into a broad band charged beam with momentum capabilities up to 200 GeV/c. At 100 GeV/c this beam would contain a very favorable flux of at least 10^5 antiprotons per pulse. A simple version of the M5 test beam is also proposed which would transmit 5×10^5 π^-/pulse at 30 GeV/c or 1×10^5 π^-/pulse at 60 GeV/c. The implementation of both of these designs is quite inexpensive and involves EPB dipoles and quads currently on hand.

A. A Charged M4 Beam

This proposal for the conversion of the M4 7.25 milliradian neutral beam in the Meson Area into a charged beam has been largely motivated by two factors:

i) the relative dearth of new proposals for experiments to utilize the existing M4 neutral beam;

ii) the extremely large number of proposals for Meson Area experiments which require a beam of charged hadrons.

We describe below the design details of a proposed conversion of the M4 beam into a charged particle ($\pi^{\pm}$, $K^{\pm}$ p and $\bar{p}$) beam. The beam would have a maximum momentum of 200 GeV/c. A relatively modest rigging effort (~1 shift) would enable the conversion of the new charged beam back into the existing M4 neutral beam configuration, and vice versa. The charged beam would contain a parallel section to enable the possible use of a "Kycia" type differential Cerenkov counter for particle identification.

The conversion of the M4 beam to a charged beam within the confines of the 14" berm pipe involves alternate left and right bends causing the charged line to zig-zag within a few inches of the present neutral kaon line. This design leads to a very small dispersion and, hence, the possibility of a large momentum bite and concomitant substantial particle flux.

Table I lists the current M4 beam elements in the various M4 beam enclosures and the projected charged beam elements. Figure 1 indicates a first order beam envelope as calculated by TRANSPORT. The optics is a simple two-stage system in both planes with a parallel section in the second section. A second order TRANSPORT run indicates that the final beam spot will be less than 1 cm diameter even with a 10% FWHM $\Delta p/p$ momentum bite. The minimum momentum bite will be 2% FWHM.

The offset in the collimators required at the 400', 600', and 1000' gallerys can be affected either by physical movement of the present neutral beam collimators or by addition of inserts to the collimators, thereby shifting their effective center. There are no other geometrical changes required to change from the neutral to the charged configuration; thus the changeover would require less than one shift. A power supply change might also be required to ensure stability at the very low currents needed in the sweeping magnets.

Estimates of the M4 charged beam intensities can be made based on extrapolations of particle production data at 3.5 mrad by Experiment 104 and at 7.25 mrad by Experiment 82. Estimates of $\bar{p}/\pi^-$ intensity ratios are based on a discussion of $\bar{p}/\pi^-$ ratios in Proposal-302.

Proton beam energy assumed:	300 GeV
Proton beam intensity assumed:	10^{13} protons/pulse
Proton beam target assumed:	8" long Be target
$\Delta p/p$ acceptance - defined by momentum slit M4C3:	±5% HWHM
$\Delta p/p$ resolution limit (by using minimal p/p acceptance):	±1% HWHM
$\Delta p/p$ acceptance amount in M4C beam intensity estimates:	±5%
Beam diameter (2nd order transport run ±5% $\Delta p/p$):	1.2 cm x .6 cm

Momentum	Particle Intensity Per Pulse		
	$\pi^{\pm}$	K^{+}	$\bar{p}$
50	10^{7}	2×10^{6}	2×10^{5}
100	2×10^{6}	5×10^{5}	10^{5}
150	5×10^{5}	10^{5}	

A crude check of the charged particle yield was made by us in the M4 beam using a simple scintillator telescope off-center at the 600' enclosure. These measurements confirmed the predictions to within a factor of about 3. Note: with the $\pi^{-}/\bar{p}$ ratio indicated at 100 GeV/c, it should be possible with MWPC's and a differential Cerenkov counter in the incident beam to tag and determine the momentum very accurately for at least 10^5 $\bar{p}$/pulse. It is possible that the Preuss counter currently in the M1E branch would be available and could be used for particle identification.

The main expense in implementing this proposed beam involves the assignment of four 3Q60 quads, two 3Q120 quads, and the two 5 ft EPB dipoles to be exchanged for a 10' EPB dipole.

B. The M5 Test Beam

We attempt here to revive a previous, very simple design for the M5 charged particle test beam. The motivations for the design at this time include two factors.

i) The lack of a reasonably intense, simple-to-operate test beam facility at Fermilab.

ii) The large number of short tests and quick experiments which the Meson Laboratory has been asked to accommodate in its three charged beams in the last year.

The envisioned configuration of this beam is a simple two-stage point-to-point focussing system. The optics should enable the beam to run either with a high flux and rather poor spot or a smaller flux with a much improved focus. The focus is kept well upstream in the M5 enclosure so that adequate space exists for both test facilities and a beam stop before the beam reaches the Meson Detector Building floor.

Table II lists the proposed elements in the beam line. Figure 2 indicates a first order beam envelope as calculated by TRANSPORT. A second order calculation reveals a beam spot size of about .2 cm diameter for .1% FWHM $\Delta p/p$, the minimum momentum bite, and a 1 cm diameter spot for .6% FWHM $\Delta p/p$, the maximum momentum bite. We feel this is adequate for such a test beam.

Flux estimates for this beam have been made using the

Sanford-Wang fit as modified by Wang to fit the data of Baker, et al, in the M1 beam. The pion yield is calculated for 3 x 10^{12} 400 GeV protons incident on an 8" Be target per pulse and a .5% FWHM $\Delta p/p$ momentum bite.

Pion Flux Per Pulse

	π^+	π^-
20 GeV/c	8 x 10^5	6 x 10^5
40 GeV/c	5 x 10^5	4.5 x 10^5
60 GeV/c	1.5 x 10^5	1.5 x 10^5

This beam could be built in either a 30 GeV/c maximum momentum version or a 60 GeV/c maximum momentum version depending on the availability of EPB dipoles. 30 GeV/c requires four 3Q60 EPB quads, three 5-1.5-120 EPB dipoles, and one 5-1.5-60 EPB dipole. Upgrading to 60 GeV/c requires an additional three 5-1.5-120 EPB dipoles. One pair of x, y collimators will suffice to define both the momentum and angle aperature of the beam line.

Currently some power supplies, control rack space and buss-work in the M5 tunnel exist having been installed during the original construction phase of the Meson Laboratory. Besides the magnets, about 1000 feet of 4" beam pipe will be required for the installation of the beam.

TABLE 1

M4 Beam Line Elements

	Z(ft)	Description
Front End Hall	246	Present beam stop, replace with 3Q60
	254	Present 5-1.5-120 dipole, replace with 5-1.5-60 dipole
	262	Add 3Q60
400' Enclosure	368	Fixed collimator (½" x ½"), must be 2" x 1" for max. charged beam
	390	Muon spoilers presently not used, replace with beam stop
600' Enclosure	655	Horizontal collimator, charged beam centered 7 cm east
	661	Vertical collimator, first focus for charged beam
	667	5-1.5-120 sweeping magnets
1000' Enclosure	1008	Add 3Q60 quadrupole
	1018	Add 3Q60 quadrupole
	1021	Horizontal collimator, charged beam centered 7 cm west
	1027	Vertical collimator
	1040	5-1.5-120 sweeping magnets
1300' Enclosure	1322	Possible location of differential Cerenkov counter
	1350	Add 5-1.5-60 EPB dipole
1600' Experimental Pit	1605	Add 3Q120 EPB quadrupole
	1616	Add 3Q120 EPB quadrupole
	1710	Second focus of charged beam

TABLE 2

M5 Test Beam Elements

	Z(ft)	Description
Front End Hall	62.0	Vertically focussing 3Q60 quadrupole
	68.5	Horizontally focussing 3Q60 quadrupole
	126.0	5-1.5-120 EPB dipole
	135.0	5-1.5-60 EPB dipole
	144.0	5-1.5-120 EPB dipole (for 60 GeV/c)
M5 Tunnel	685.0	Horizontal collimator
	690.0	Vertical collimator, first focus
	701.75	5-1.5-120 EPB dipole (for 60 GeV/c)
	713.25	5-1.5-120 EPB dipole
	724.75	5-1.5-120 EPB dipole
	736.25	5-1.5-120 EPB dipole (for 60 GeV/c)
M5 Enclosure	1178.5	Horizontally focussing 3Q60 quadrupole
	1185.0	Vertically focussing 3Q60 quadrupole
	1250.0	Second focus

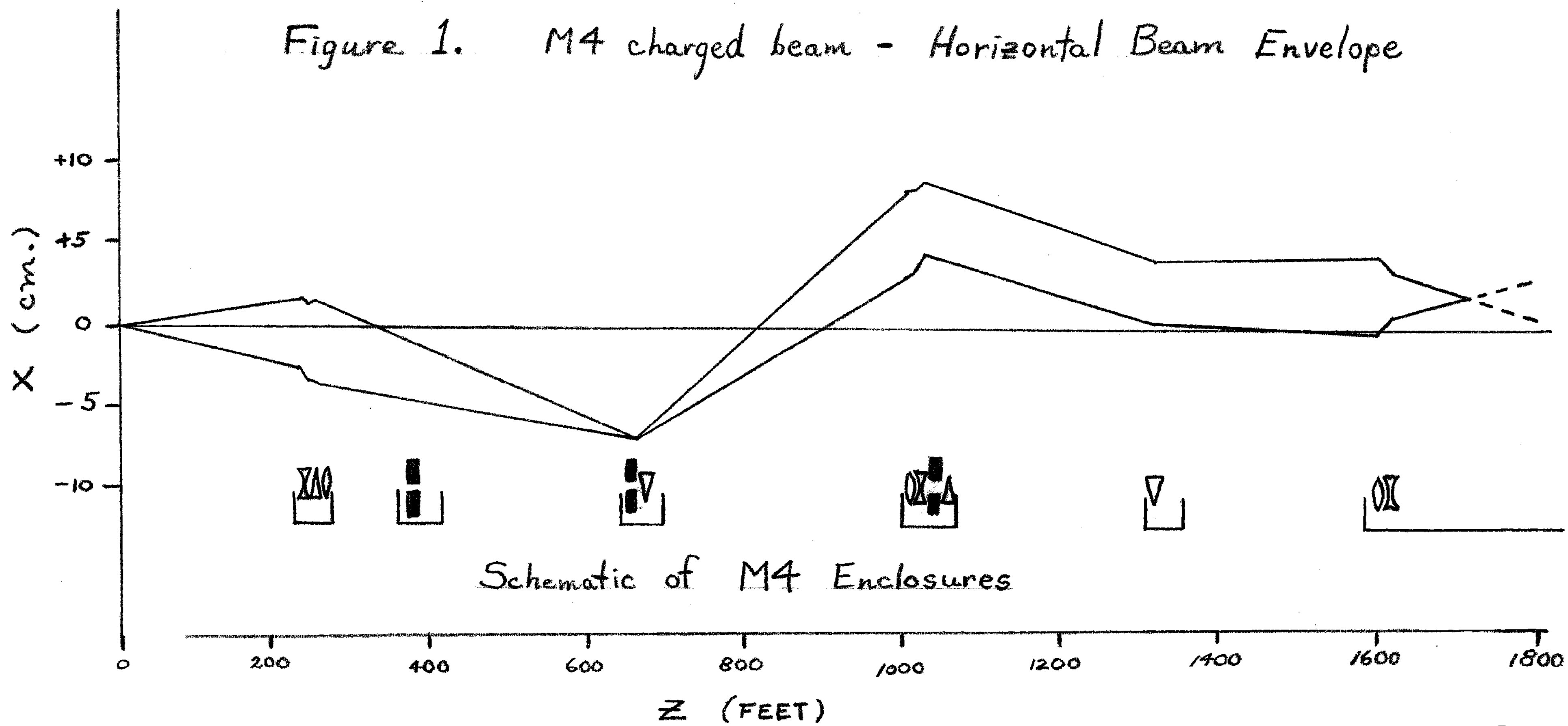
Figure 1. M4 charged beam - Horizontal Beam Envelope
+10
+5
0
-5
-10
X (cm.)
Schematic of M4 Enclosures
0
200
400
600
800
1000
1200
1400
1600
1800
Z (FEET)

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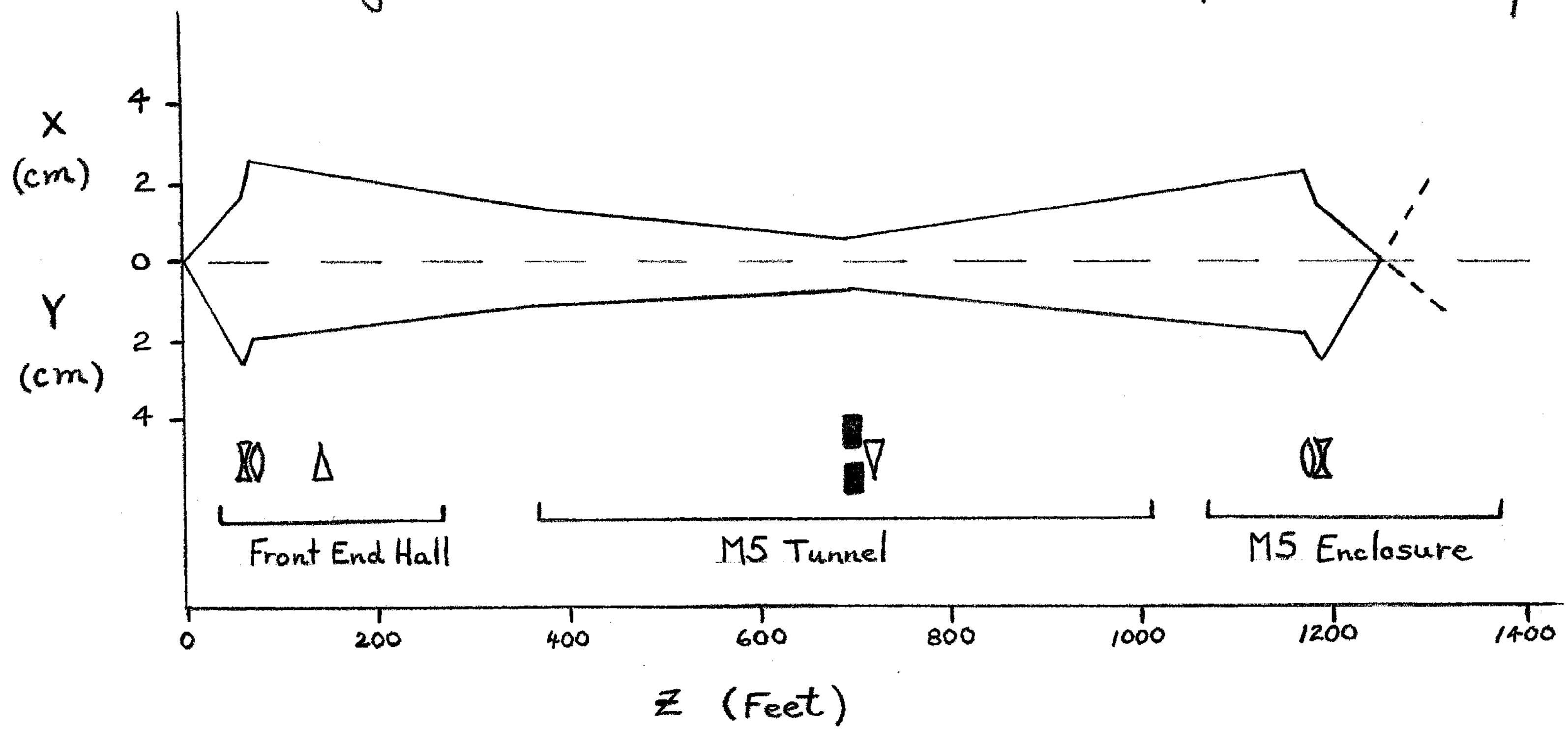
Figure 2. M5 test beam – Beam Envelope for minimum $\frac{\Delta p}{p}$.



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